

Taxonomic studies on *Zingiber* (Zingiberaceae) in China I: *Zingiber kerrii* and the synonymy of *Z. menghaiense* and *Z. stipitatum*

L. Bai^{1,2}, J. Leong-Škorničková³ & N.H. Xia¹

¹Key Laboratory of Plant Resources Conservation & Sustainable Utilization,
South China Botanical Garden, Chinese Academy of Sciences,
Guangzhou, 510650 People's Republic of China
nhxia@scib.ac.cn

²University of Chinese Academy of Sciences,
Beijing, 100049 People's Republic of China
bailin@scib.ac.cn

³Herbarium, Singapore Botanic Gardens, National Parks Board,
1 Cluny Road, 259569 Singapore
jana_skornickova@nparks.gov.sg

ABSTRACT. A general introduction to *Zingiber* is provided, along with an outline of the materials and methods used in this paper and which are to be used in our subsequent taxonomic studies on *Zingiber* in China. Based on an investigation of the protogues, and on comparisons of both the type specimens and living materials collected from the type localities and their immediate vicinities, *Zingiber stipitatum* S.Q.Tong and *Z. menghaiense* S.Q.Tong are here reduced to synonymy under *Z. kerrii* Craib. A previous lectotypification of *Zingiber kerrii* is discussed and amended. The existence of mixed collections among the isotypes of *Zingiber stipitatum* is highlighted and a proposal to exclude the vegetative parts belonging to *Z. neotrunicatum* from the type material is made. A description and a colour plate of *Zingiber kerrii* based on a collection from China are provided.

Keywords. India, Myanmar, synonym, Thailand

Introduction

Zingiber Mill. (Zingiberaceae, Zingibereae) is an economically important genus, best known for the ginger of commerce, *Zingiber officinale* (L.) Roscoe. The genus is widely distributed in tropical to warm-temperate Asia (Wu & Larsen, 2000). According to The Plant List (2013), 244 names have been published in this genus, corresponding approximately to 100–150 species (Theilade, 1999; Wu & Larsen, 2000; Kishor & Leong-Škorničková, 2013). Strongly supported as monophyletic (Kress et al., 2002), this genus is easily recognised among Zingiberaceae either by the flower structure (the horn-shaped anther crest embracing the upper part of the style) or by the vegetative character (the existence of a swollen part of the petiole, widely known as a pulvinus).

The currently accepted infrageneric classification of *Zingiber* recognises four sections, based on the nature and position of the inflorescence: (1) sect. *Zingiber*,

having a spike on an erect and, usually, long peduncle; (2) sect. *Cryptanthium* Horan., characterised by radical inflorescences composed of a spike appearing at ground level with a, usually, short procumbent peduncle; (3) sect. *Pleuranthes* Benth., with spikes breaking through the leaf sheaths laterally; (4) sect. *Dymczewiczia* Benth., with terminal inflorescences. A recent molecular study based on a single marker and limited material indicates that *Zingiber* sect. *Dymczewiczia* and *Zingiber* sect. *Pleuranthes* are not well segregated from *Zingiber* sect. *Zingiber* (Theerakulpisut et al., 2012). As more studies involving broader sampling are certainly needed before a new classification can be formally proposed, the traditional sectional treatment is utilised in our current work.

The last comprehensive taxonomic revisions of the genus are more than a century old (Horaninow, 1862; Schumann, 1904), covering only 23 and 55 species respectively. Several regional studies have been made in S & SE Asia in the meantime, e.g. Ridley (1909), Valeton (1918), Loesener (1930), Holtum (1950), Smith (1988a,b), Theilade (1996), Theilade (1999), Sabu (2003), Sabu (2006) and Triboun (2006).

Poor or missing type material, difficulties in the preservation of important floral characters on herbarium specimens through traditional drying methods, as well as variability of certain morphological characters coupled with hybridisation and polyploidy in some genera, make Zingiberaceae taxonomically one of the most challenging plants groups (Larsen, 1980; Theilade, 1999; Škorničková & Sabu, 2005; Leong-Škorničková et al., 2010; Ardiyani et al., 2011). Our current poor understanding, particularly of the larger ginger genera, is further exacerbated by the fact that many previous workers limited their area of study to a single country, rather than working monographically, leading to repeated descriptions of the same taxa. A number of taxonomists have written that the ideal approach to the taxonomic study of gingers is to work with living fertile material or material well-preserved in spirit (Smith, 1988a; Theilade, 1999; Škorničková & Sabu, 2005; Leong-Škorničková et al., 2010). This may involve revisiting and collecting plants from the type localities in order to take precise notes aided by good photo-documentation, and to preserve at least fertile bracts, bracteoles and flowers (or better still the entire inflorescence) in spirit, including having several flowers preserved separately to avoid damage (Burtt & Smith, 1976). A thorough review of the pertinent literature of the species across its phyto-geographical range and good communication between taxonomists working on gingers is also crucial.

The genus *Zingiber* in China

Fifty-three names have been associated with *Zingiber* taxa in China, of which 46 are based on types from China. The most recent taxonomic treatment of *Zingiber* is that of Wu & Larsen (2000) in the *Flora of China*. In this work, 42 species are recognised, with 34 being endemic to China. The genus is mostly restricted to the subtropical zone of China, i.e. south of the Qinling-Huaihe Line (Zhang & Tang, 1991). While the account by Wu & Larsen (2000) serves as a useful overview, the work was based

mostly on the study of imperfectly preserved herbarium material, of which most are not accompanied by spirit material. This resulted in short and often incomplete descriptions lacking basic rhizome and floral characters, and in doubtful synonymies. About a quarter of Chinese *Zingiber* species are known only from the type collections and their identities are poorly understood. There are also a number of presumably well-known species to which a certain name has been applied for an extended period of time, sometimes simultaneously to more than one species, and yet an understanding of what these species really are is not straightforward. These issues can only be unravelled with detailed taxonomic work.

While a thorough revision of *Zingiber* in China is far from complete, accounts for various regional floras in neighbouring countries are in progress. It is therefore useful to disseminate our existing results which include clarifications of the identities of various taxa, the establishment of new synonyms, and the descriptions of new taxa. The present paper, clarifying the identities of two species from Yunnan, *Zingiber menghaiense* S.Q.Tong and *Z. stipitatum* S.Q.Tong, is the first in the series. It, therefore, includes a more detailed introduction to the genus as outlined above, as well as an explanation of the materials and methods applied in our studies, the details of which will not be repeated in subsequent papers.

Material and methods

Our work on a revision of *Zingiber* in China was initiated in 2011. The protogues of all published names along with all other pertinent literature on the genus were collated and reviewed. Searches were made in the relevant herbaria for the original material or type material identified from the protogues. All Chinese specimens of *Zingiber* from China were examined at CDBI, EMA, GXMG, GXMI, HGAS, HITBC (in older literature often referred as YNTBI), IBK, IBSC, KUN, LBG, PE, SYS. Additional material from China and neighbouring countries (particularly Thailand, Laos and Vietnam) was mostly accessed as hi-resolution digital images from the following herbaria: AAU, BK, BKF, BM, C, E, G, HAST, K, KFRI, L, P, SING, TAI, TAIF, US, W, WU. Since 2012 the first author has conducted extensive fieldwork to re-collect fertile material from type localities or their vicinities. Spirit collections, consisting of fertile bracts, bracteoles and single flowers, were made in the field for further study. Extensive photographic documentation was also made following the protocols established by Leong-Škorničková et al. (e.g. 2014a, 2014b). Rhizomes were collected and brought for planting to the greenhouse in South China Botanic Garden for further observation. The terminology in general follows Beentje (2010) and the recent works of Kishor & Leong-Škorničková (2013) and Leong-Škorničková et al. (2014a). While some previous works (e.g. Theilade, 1999; Wu & Larsen, 2000) treated the labellum as a tri-lobed structure composed of a mid-lobe and two side lobes (implying the absence of staminodes in the genus *Zingiber*), this approach has not been supported by any morphological study and is not in accord with our current knowledge of ginger flower structure. In Zingiberaceae, of the six stamens, only the median posterior stamen

of the inner whorl is fertile, while the remaining two are sterile and connate into a labellum. Of the outer whorl, one of the stamens is fully reduced, while the remaining two appear as sterile staminodes (ranging in shape from large and petaloid to small teeth-like structures), flanking the stamen or adnate to the labellum (e.g. Larsen et al., 1998). Petaloid staminodes strongly adnate to labella occur in other Zingiberaceae genera, e.g. *Siliquamomum* or *Siphonochilus*. We therefore agree with the conclusion of various authors (e.g. Ridley, 1899; Holttum, 1950; Smith, 1988a; Larsen et al., 1998) that the side lobes in *Zingiber* are staminodes, which in some species are free to the base and in others are well developed and might be either fully or partially connate to the labellum. In a few species they may be almost fully reduced or even missing. The way we have measured the labellum and lateral staminodes is shown in Fig. 1. The degree of connation is also an important character which should be included in descriptions.

The identities of *Zingiber menghaiense* and *Z. stipitatum*

During initial herbarium work it was noticed that the holotypes of *Zingiber menghaiense* S.Q.Tong and *Z. stipitatum* S.Q.Tong appear to belong to the same taxon (Fig. 2 A–C). At the same time it was also noticed that two of the three existing isotypes of *Zingiber stipitatum* consisted of mixed collections (Fig. 2C). Furthermore, two specimens originally identified as *Zingiber stipitatum* and collected from the vicinity of the type locality of *Z. menghaiense* (Pei, S.J. 11344 in KUN) were redetermined as *Z. kerrii* Craib by Dr Pramote Triboun in 2002. This prompted us to investigate the complex of these three names in greater detail.

Zingiber menghaiense (Tong, 1987) was described from two collections from Xishuangbanna in south Yunnan, China, *Tong, S.Q. & Li, A.M.* 32860 from Menghai Xian and *Tong, S.Q. & Li, A.M.* 32902, from Jinghong city, with the HITBC specimen of the former collection being designated as the holotype (Fig. 2A). When first described, it was inexplicably compared to *Zingiber zerumbet* (L.) Roscoe ex Sm., a very different species with incurved bracts, rather than to other more similar species with appressed bracts.

In the same article, Tong (1987) described *Zingiber stipitatum* based on a single collection, *Tong, S.Q. & Liao, C.J.* 24836 from Ruili Shi, Dehong Zhou, in the southwest of Yunnan (holotype HITBC48857, Fig. 2B). In the protologue it was compared to *Zingiber menghaiense*. Both species have a narrow, lanceolate, glabrous lamina of similar size and shape, a long erect peduncle, an oblong or narrowly ovoid spike, pale green bracts with a purple red margin, a whitish labellum, and lateral staminodes with red patches on both sides of the bases. *Zingiber stipitatum* was said to differ by the following characters: (1) the ligules 6 mm long, emarginate (versus 6 mm long, bilobed in *Z. menghaiense*); (2) the labellum orbicular with emarginate apex and petiolate [meaning it has an attenuate base or is clawed] (versus labellum narrowly obovate, apex bifid in *Z. menghaiense*); (3) the entire lateral staminodes which are shortly acuminate at the apices (versus bifid at apices in *Z. menghaiense*).

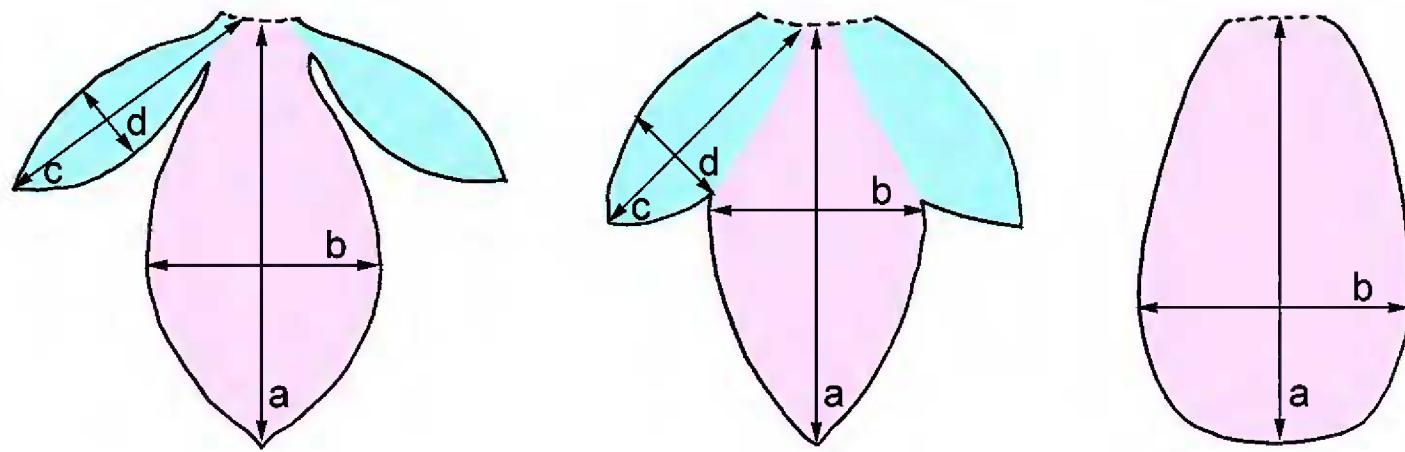


Fig. 1. Schematic outlines of selected types of labellum (pink) and lateral staminodes (blue) occurring in the genus *Zingiber*. From left to right, lateral staminodes nearly free from labellum, lateral staminodes connate to labellum by basal $\frac{2}{3}$, lateral staminodes absent. (a) length of labellum, (b) width of labellum, (c) length of lateral staminodes, (d) width of lateral staminodes.

A comparison of the holotypes of the two species reveals that they are quite similar to each other. Also, the holotype of *Zingiber stipitatum* does not match the protologue as the ligules are c. 3 mm long and clearly 2-lobed. Though shorter, the ligules of *Zingiber stipitatum* are also very similar to those of *Z. menghaiense* in their nearly coriaceous texture, being slightly pubescent, with a prominent raised vein on the base and the membranous margin. As pointed out by Triboun (2006), the length of ligules in *Zingiber* varies according to the position of leaves on the pseudostem and those in the middle part of the shoot are usually longer than the others. Three isotypes of *Zingiber stipitatum* were located at HITBC and KUN herbaria (HITBC49032, KUN0833208 and KUN0833209). Further examination of these sheets revealed that while the isotype at HITBC is of the same taxon as the holotype, the plant parts mounted on the other two isotypes at KUN (KUN0833208, KUN0833209 (Fig. 2C)) belong to two different species. The ligules on the shoots are emarginate and c. 6 mm long, consistent with the description and the painting in the protologue, while they conflict with the protologue and the holotype in the lower lamina surface, sheaths and ligules being densely villous (they are glabrous in the protologue and holotype). These two shoots are easy to recognise as *Zingiber neotrunca*tum T.L.Wu, K.Larsen & Turland, which also occurs in Ruili as mentioned in its protologue (Tong, 1987), while the inflorescences are certainly of *Z. stipitatum* (the inflorescence of *Z. neotrunca*tum has shorter peduncles and is more or less bent and without a dark brown tinge on the tips of the bracts). As confirmed by the first author in the field, *Zingiber neotrunca*tum is quite common at the type locality of *Z. stipitatum*. It appears that the description of *Zingiber stipitatum* in the protologue is based on these two different species. The character of the ligules being emarginate, the only vegetative character used by Tong (1987) to distinguish *Zingiber stipitatum* from *Z. menghaiense*, is derived from the leafy shoots of *Z. neotrunca*tum present in the two isotypes. After their exclusion, all the remaining original materials show no critical differences to the type specimens of *Zingiber menghaiense*. Further observation of floral characters was made through

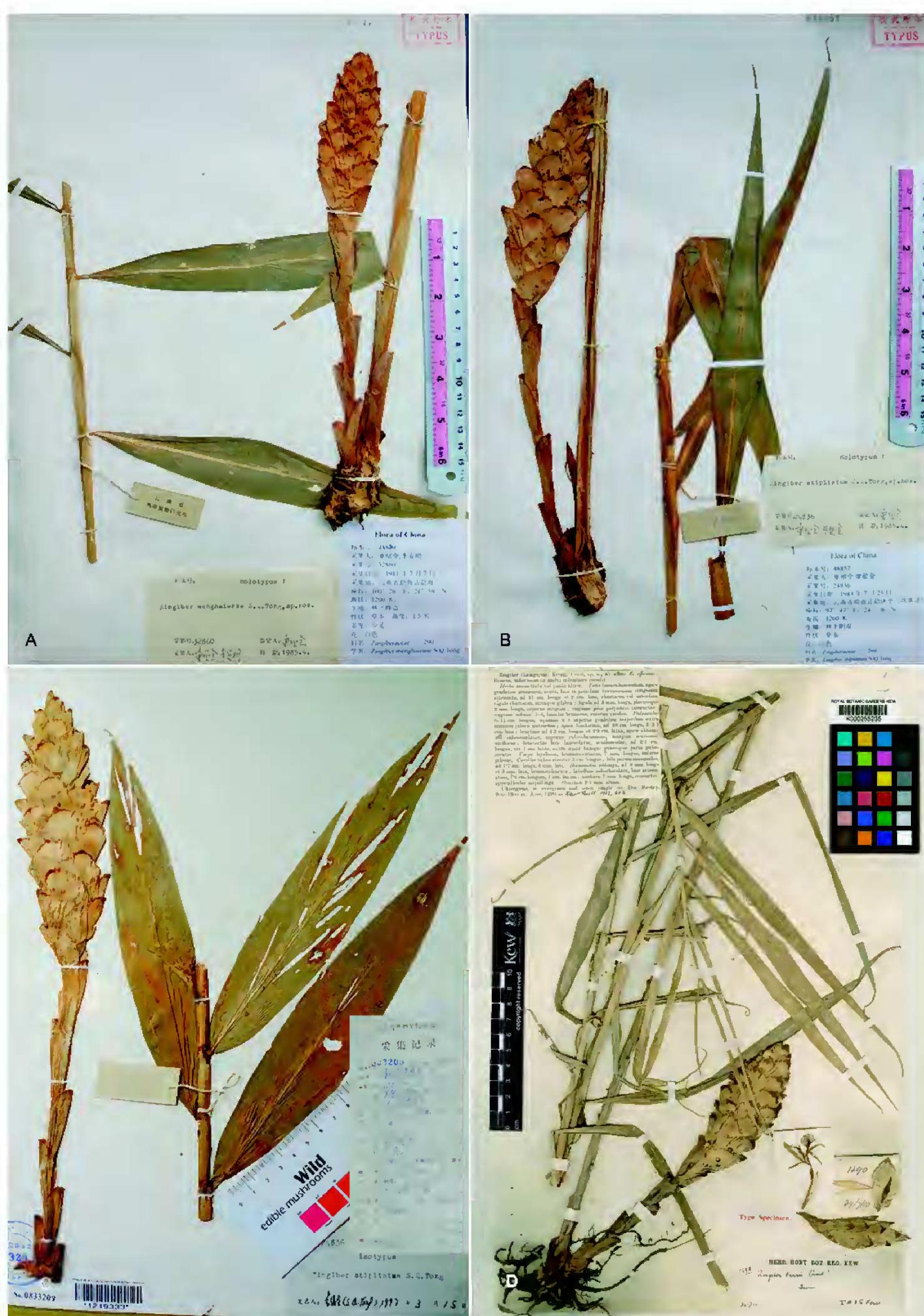


Fig. 2. *Zingiber kerrii* Craib. **A.** Holotype of *Z. menghaiense* S.Q.Tong (*Tong, S.Q. & Li, A.M. 32860, HITBC Acc. No. 048849*). **B.** Holotype of *Z. stipitatum* S.Q.Tong (*Tong, S.Q. & Liao, C.J. 24836, HITBC Acc. No. 049032*). **C.** One of the two mixed isotypes of *Z. stipitatum* S.Q.Tong; the inflorescence belongs to *Z. stipitatum*, the leafy shoot belongs to *Z. neotruncatum* (*Tong, S.Q. & C.J. Liao, C.J. 24836, KUN Acc. No. 0833209; barcode 1219333*). **D.** Lectotype of *Zingiber kerrii* Craib (*Kerr, A.F.G. 1290; barcode K000255235*); reproduced with the kind permission of the Director and the Board of Trustees, Royal Botanic Gardens, Kew.

the field work of the first author in 2012 and 2013. More than ten individuals were found at the type locality of *Zingiber menghaiense*, with the flowers examined having entire lateral staminodes (as opposed to staminodes with bifid apices as stated in the protologue) but all other characters matched the protologue and the type specimens well. According to our observation of several other *Zingiber* species (i.e. *Z. longyangjiang* Z.Y.Zhu), the phenomenon of lateral staminodes being bifid to various degrees occurs occasionally in populations with otherwise entire staminodes, and is therefore not to be considered a reliable character to distinguish two species. The shape of the labellum also varies within and between populations and we have observed varying degrees of narrowing at the bases and notches at the apices which covers the shapes of labella as depicted in the line drawings of *Zingiber stipitatum* and *Z. menghaiense* published in the protogues. At the type locality of *Zingiber stipitatum*, which is 360 km away (as the crow flies) from the type locality of *Z. menghaiense*, only *Z. neotruncatum* was found. However, plants matching the description of *Zingiber stipitatum* were found within 20 km of the type locality and these are identical to those from the type locality of *Z. menghaiense*. It is, therefore, concluded here that *Zingiber stipitatum* is the same taxon as *Z. menghaiense*.

The identity of *Zingiber kerrii* Craib

Zingiber kerrii Craib was described in 1912 from a collection from Northern Thailand (Chiang Mai Kerr 1290, Fig. 2D) (Craib, 1912). It was included in the revisions of *Zingiber* in Thailand by Theilade (1999) and Triboun (2006) and both works included photos of the inflorescence and flower. The species was also reported to occur in Shan state in Myanmar (Kress et al., 2003) and in Manipur state in India (Thongam et al., 2013). Compared to the Thai collections (Theilade, 1999; Triboun, 2006), the Indian collection is slightly different by having the labellum and lateral staminodes creamy white throughout. Our collection of *Zingiber menghaiense*, approximately 400 km away from the type locality of *Z. kerrii*, shows more resemblance to *Z. kerrii* than the Indian record, especially in the coloration of the labellum and lateral staminodes. Even though the laminas are only c. 2.5 cm wide in the type material of *Zingiber kerrii*, and described as 2.3 cm wide by Triboun (2006), they can reach up to 5 cm wide in some other specimens in Thailand, similar to the measurements reported from India (Thongam et al., 2013). Chinese collections consistently have laminas 3.5–4 cm wide. In conclusion, we agree with Triboun that *Zingiber menghaiense* (and also *Z. stipitatum* as noted above) is the same taxon as *Z. kerrii*. Therefore, *Zingiber menghaiense* and *Z. stipitatum* are reduced to synonymy under *Z. kerrii*. Colour plates, including a flower dissection of *Z. kerrii* from Yunnan, are provided (Fig. 3, Fig. 4).

Theilade (1999), in her revision, indicated the presence of syntypes of *Kerr 1290* at BK, BM, E and K and proposed the lectotypification of *Zingiber kerrii* with a specimen deposited at K. However, the Kew herbarium has two specimens of *Kerr 1290*, both of which contain both a leafy shoot and an inflorescence, and as there is no indication that these two specimens are part of a single preparation, a further

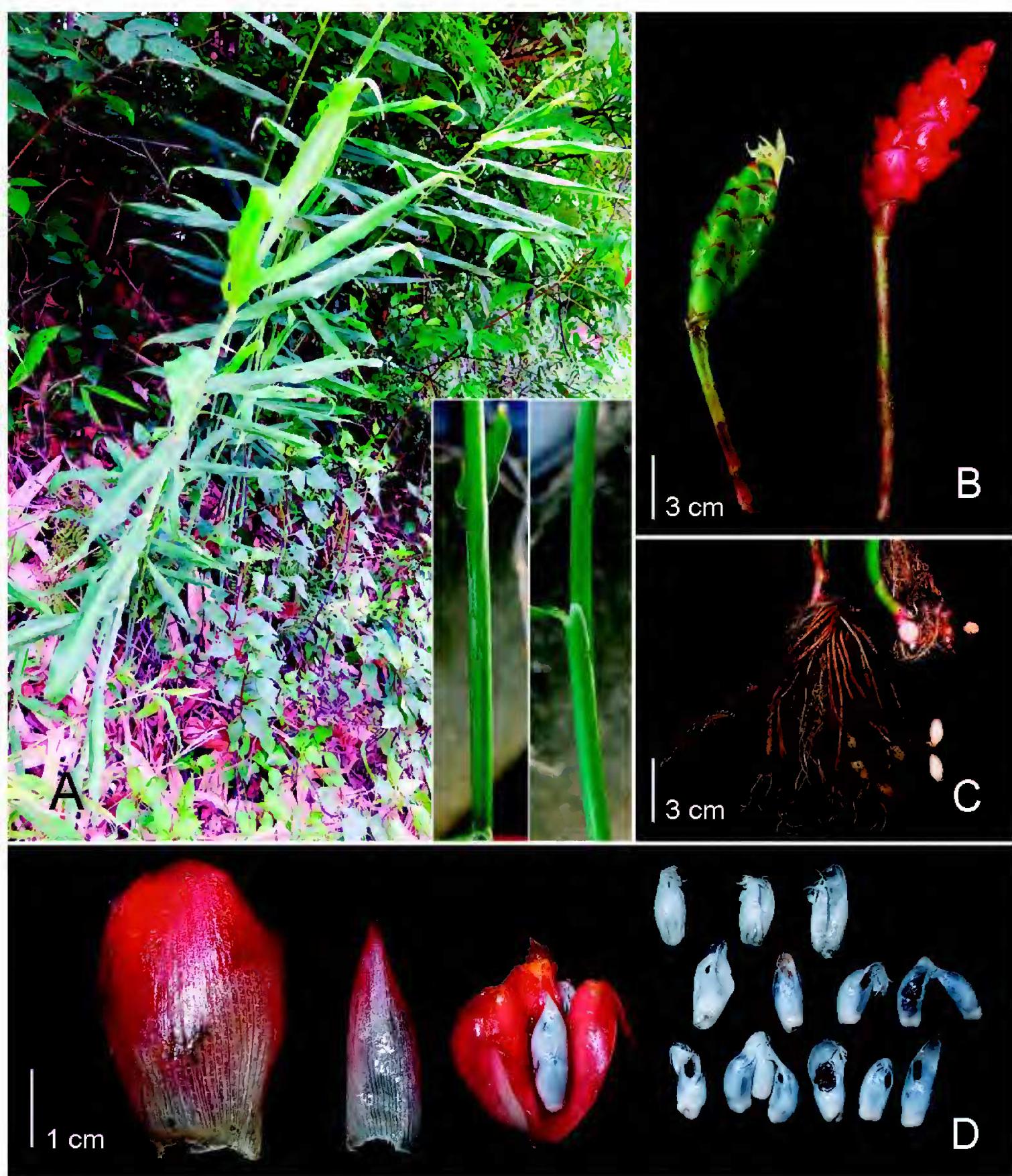


Fig. 3. *Zingiber kerrii* Craib. **A.** Young shoots (inset: leaf sheath and ligule). **B.** Inflorescences (left at anthesis, right in fruit). **C.** Old rhizome with root tubers and section of young rhizome and root tubers. **D.** From left: Bract, bracteole, mature capsule (dehisced) and seeds enclosed in arils. From *Bai, L. 13080301* and *Bai, L. 12091402*, from the type locality of *Zingiber menghaiense*. (Photos: L. Bai)

second step lectotypification is needed. In conformity with the ICN (Arts. 8.3, 9.17) we designate here one of these two specimens, which also contains a flower dissection (barcode K000255235), as the lectotype.

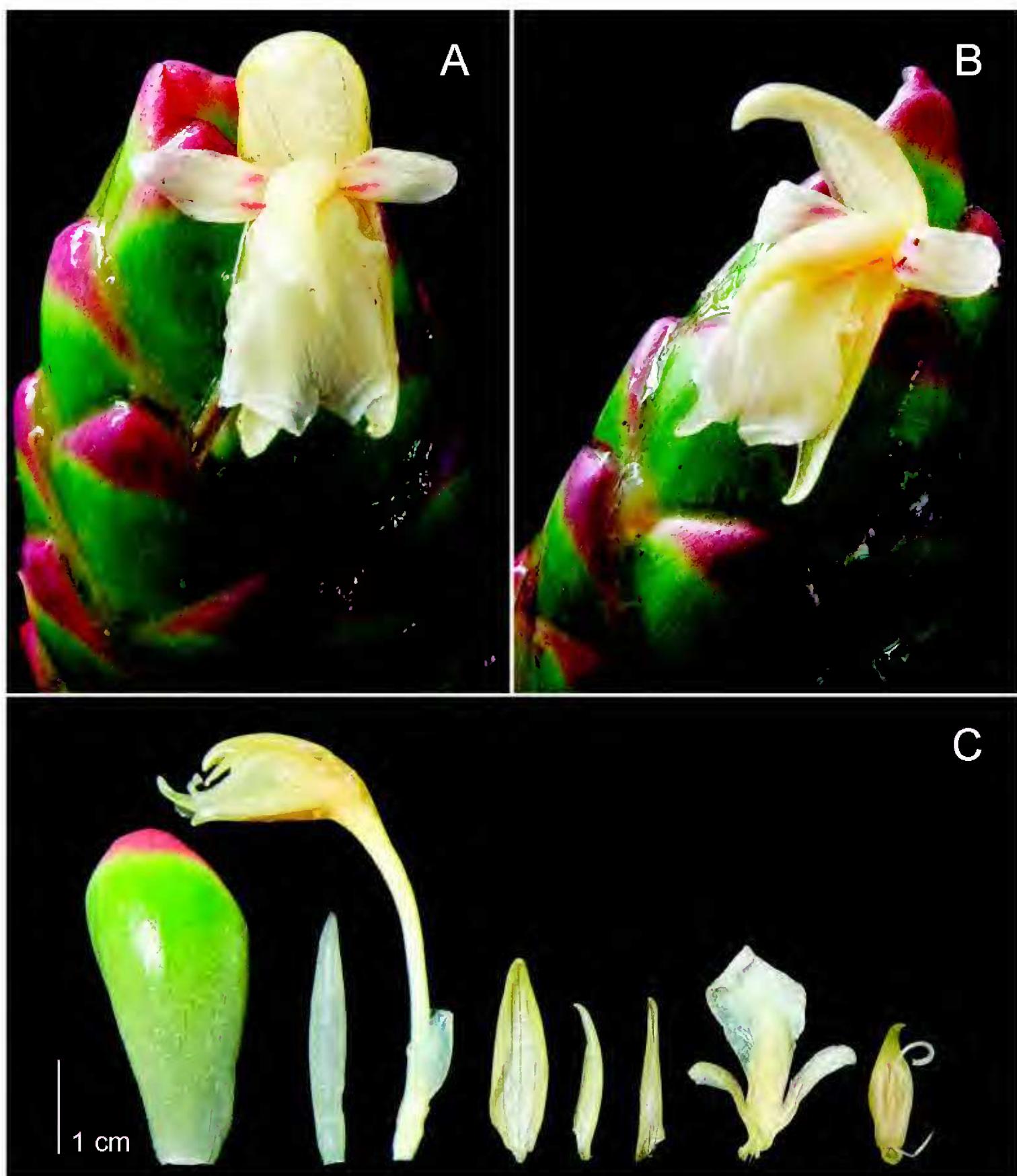


Fig. 4. *Zingiber kerrii* Craib. **A.** Flower (front view). **B.** Flower (semi-side view). **C.** Flower dissection (from left to right: bract, bracteole, single flower in side view, dorsal corolla lobe, two lateral corolla lobes, labellum with lateral staminodes partially basally connate, stamen with upper part of style in the groove between two anther thecae. From the type locality of *Zingiber menghaiense*, Bai, L. 13080301. (Photos: L. Bai)

Zingiber kerrii Craib, Bull. Misc. Inform. Kew. 10: 403 (1912); Loesener in Nat. Pflanzenfam. 15a: 588 (1930). – TYPE: Thailand, Chiang Mai, Doi Sootep, in evergreen jungle, 660 m., 24 July 1910, Kerr, A.F.G. 1290 (lectotype K! [K000255235],

designated here; isolectotypes BK n.v., BM! [BM000858181], E! [E00097850], K! [K000255234], P! [P00450941]).

Zingiber menghaiense S.Q.Tong, Acta Phytotax. Sin. 25 (2): 145–146, pl. 1, f. 2. (1987); S.Q.Tong in Fl. Yunnan 8: 533 (1997); T.L.Wu & K.Larsen in Fl. China. 24: 326 (2000), **synon. nov.** – TYPE: China, Yunnan Province, Xishuangbanna Daizu Zizhizhou, Menghai Xian, Menghai Zhen, under the forest on the roadside, 1200 m, 2 Jul 1982, *Tong, S.Q. & Li, A.M.* 32860 (holotype HITBC! [catalogue number 048849]; isotype KUN! [catalogue number 0833203]).

Zingiber stipitatum S.Q.Tong, Acta Phytotax. Sin. 25 (2): 146–147, pl. 1, f. 3. (1987); S.Q.Tong, in Fl. Yunnan 8: 532 (1997); T.L.Wu & K.Larsen in Fl. China. 24: 326 (2000), **synon. nov.** – TYPE: China, Yunnan Province, Dehong Daizu Jingpozu Zizhizhou, Ruili Shi, Mengxiu Xiang, on the way from Mengxiu Cun to Daoba Zhai, 1200 m, 25 Jul 1983, *Tong, S.Q. & Liao, C.J.* 24836 (holotype HITBC! [catalogue number 48857]; isotypes HITBC! [catalogue number 49032], KUN! ([catalogue number 0833208], pro parte, excluding the leafy shoot), KUN! ([catalogue number 0833209], pro parte, excluding the leafy shoot).

Perennial rhizomatous herb 1.2–1.6(–2.5) m tall, glaucous throughout (although not obviously so when old). **Rhizomes** fleshy, densely branched, 10–20 mm in diameter, light brown externally, internally purple-pink when young, orange-yellow when old; **root tubers** ovate to fusiform, c. 2 × 1 cm, externally whitish brown, internally pale grey. **Leafy shoots** to 15 in a tuft, with up to 44 leaves when flowering, less

than from the base leafless; **leaf sheaths** longitudinally striate, tubular at base; **ligule** 1–4(–6) mm long, bilobed, apices obtuse triangular, base green, turning blackish and coriaceous when old, with obvious raised veins, upper part hyaline, membranaceous, densely pubescent, glabrescent when old; **petiole** to 9 mm long, consisting of pulvinus only, sparsely pubescent; **lamina** linear to narrowly-ovate, 15–34 × 1.8–3(–4.5) cm, glaucous and glabrous on both side, base obtuse to attenuate, apex acuminate. **Inflorescences** 1–3, radical; **peduncles** 12–20 cm long, erect, with pink scales on the base; **spikes** fusiform or cylindrical, apices acute, 10–15 × 5–6 cm, **fertile bracts** each subtending one flower, broadly obovate or broadly spatulate, slightly longer than the floral tube, green with purple red apices, 3–4.5 × 2–4 cm, apices rounded, whole spikes turning scarlet when fruiting; **bracteoles** narrowly ovate, apex acute, c. 30 × 6 mm, semi-translucent, sparsely pubescent externally, glabrous internally. **Flowers** 5–6 cm long; **calyx** tubular, membranaceous, c. 1 cm long, unilaterally split to 4 mm, apex slightly dentate or nearly truncate, sparsely pubescent outside, glabrous inside, semi-translucent; **floral tube** creamy white, c. 3 cm long; **dorsal corolla lobe** narrowly ovate, c. 18 × 9 mm, cream-white, concave, glabrous, apex mucronate; **lateral corolla lobes** narrowly ovate, c. 18 × 7 mm, creamy, glabrous; **labellum** obovate with conspicuous attenuate base, c. 26 × 12 mm, creamy, with purple red patch on the base, apex emarginate or bifid, margin revolute; **lateral staminodes** narrowly obovate, narrowly oblong or narrowly triangular, c. 18 × 4 mm, basal 1/5, or even less, connate to labellum,

creamy with two purple-red patches on the base, apex rounded to attenuate. **Stamen** c. 17 mm long; *filament* reduced to less than 1 mm, *anther* c. 11 mm long, connective tissue pale yellow, *anther thecae* 11 mm long, dehiscing throughout entire length, pollen pale yellow, *anther crest* c. 6 mm long, pale yellow. **Style** filiform, white, glabrous; *stigma* funnel form, white, ostiole ciliate. **Ovary** cylindrical, pale yellow, trilocular, central placentation, with c. 20 ovules in each locule, c. 5 × 3 mm, densely pubescent; *epigynous glands* two, pale yellow, c. 4 mm long, 0.3 mm in diameter, apex blunt. **Fruits** obovoid to nearly spherical or bluntly trigonous capsules, c. 22 × 18 mm, sparsely villous, greenish-cream with red tinge externally, red internally; *seeds* obovoid, c. 5 × 4 mm, dark brown, glossy, with obvious white hilum on the base; aril white, sac-like, apex with irregular margin, covering most of the seed.

Distribution. *Zingiber kerrii* is distributed in India, China, Myanmar and Thailand. (Fig. 5). According to our photographic records, the species is also present in Laos (Leong-Škorničková, unpublished).

Ecology. In China, *Zingiber kerrii* occurs in grassy areas on the forest edge, in bamboo forest and evergreen broad-leaf forest at altitudes of 700–1300 m.

Provisional IUCN conservation assessment. Least Concern (LC). This species has a large extent of occurrence (around 230,000 km²) and is known from more than 10 localities of which some are protected. We, therefore, provisionally propose this species to be Least Concern (LC) according to the latest IUCN criteria (2012).

Additional specimens examined. CHINA: YUNNAN: Dehong Daizu & Jingpozu Zizhizhou, Lianghe Xian, Mengyang Zhen, Dangliang Cun, 26 Sep 2012, *Bai*, L. 12092603 (IBSC); *ibidem*, 17 Aug 2013, *Bai*, L. 13081701 (IBSC); Ruili Shi, Mengliu Xiang, Mangling Cun, Moli, 21 Sep 2012, *Bai*, L. 12092103 (IBSC); Xishuangbanna Daizu Zizhizhou, Jinghong Shi, Jinuo Xiang, Longpa cun, *Zhou*, S.S. 3212 (HITBC); Menghai Xian, Menghai Zhen, Manduan Cun, 14 Sep 2012, *Bai*, L. 12091402 (IBSC); *ibidem*, 3 Aug 2013, *Bai*, L. 13080301 (IBSC); Mengla Xian, on the road from Mengxing Xiang to Manla Zhen, 1100 m, 21 Oct 2005, *Zhou*, S.S. 3069 (HITBC); Mengla Xian, Yiwu Xiang, 700 m, 9 Nov 1959, *Pei*, S.J. 59-11344 (two sheets in KUN); Zhenyue Xian (Mengla Xian), 1200 m, Nov 1936, *Wang*, C.W. 80620 (PE).

THAILAND: CHIANG MAI: Chom Thong District, Vachi Ratharn Waterfall on Doi Intanon, 650–800 m, 15 Sep 1995, *Larsen, K. et al.* 46498 (AAU); Doi Sutep, 1250 m, 30 Jul 1968, *Sorensen, T. et al.* 3948 (AAU); Doi Sutep, 1120 m, in 1958, *Sorensen, T. et al.* 4539 (AAU); Inthanon National Park, 850 m, 22 Jul 1988, *Phengklai, C. et al.* 6757 (BKF); Mae Sa, Rock Tower Mountain, 18 Sep 1995, *Larsen, K. et al.* 46636, (AAU); Pong Pho 12 km of Doi Chieng Dao, 1200 m, 30 Jul 1968, *K. Larsen et al.* 2874 (E, AAU, BKF); PHITSANULOK: Chat Trakan District, Phu Soi Dao National Park, 20 Jul 2006, *Poulsen, A.D. & Suksathan, P.* 2401 (E); CHAIYAPHUM: Thep Sathit District, 29 Aug 2001, *Pooma, R. et al.* 2940 (BKF).

Notes. *Zingiber kerrii* is similar to *Z. laoticum* Gagnep. in the entire plant being glaucous externally (particularly prominent in young shoots, becoming inconspicuous when older), bracts pale green with pink-red margins and rhizomes and pseudostems purple-red internally. *Zingiber laoticum* differs from *Z. kerrii* by the broader labellum which

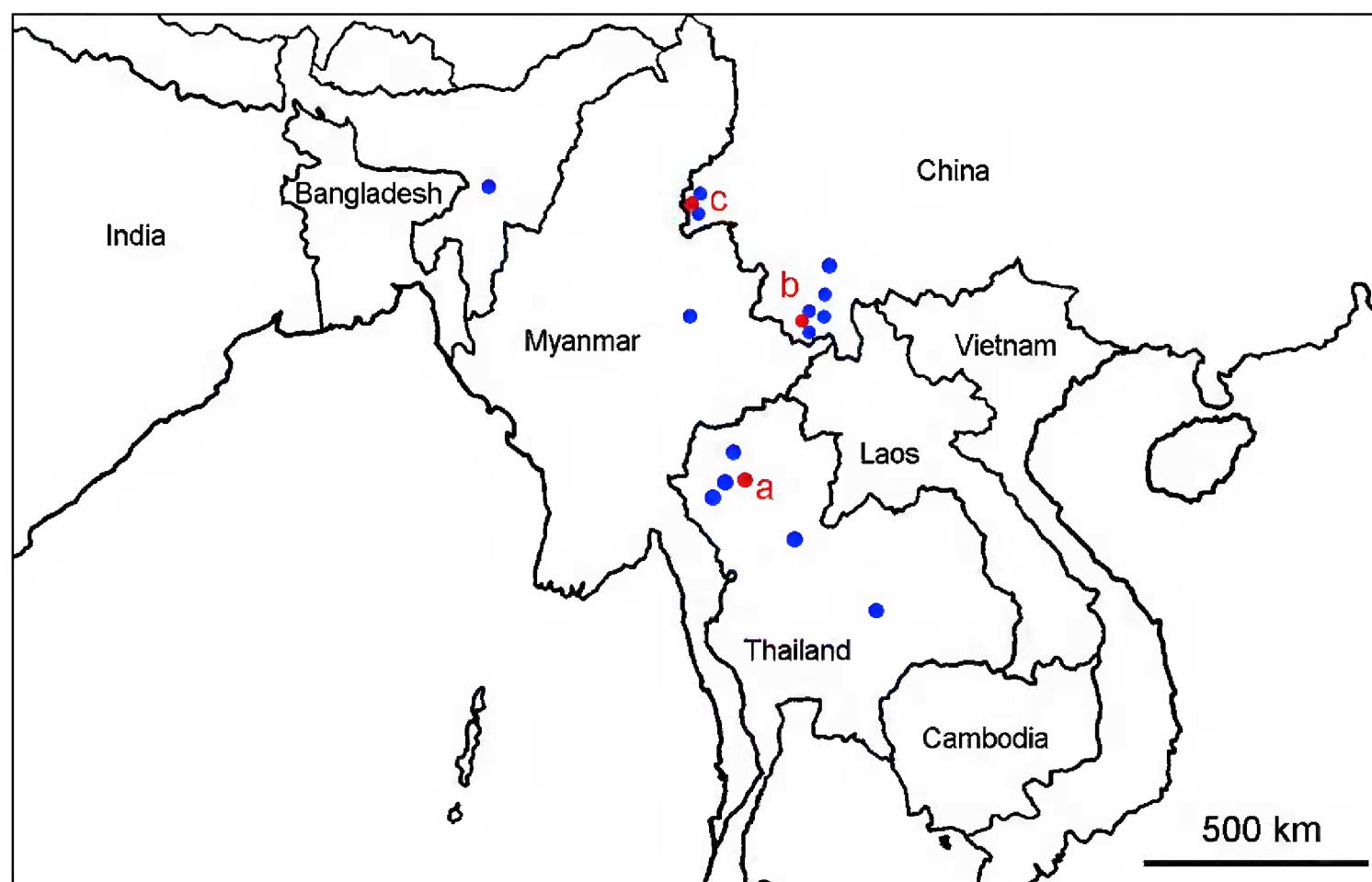


Fig. 5. Distribution of *Zingiber kerrii* Craib, based on herbarium material and literature records. The type localities of the three names are indicated in red. (a) *Zingiber kerrii* Craib, (b) *Z. menghaiense* S.Q.Tong, (c) *Z. stipitatum* S.Q.Tong.

is richly mottled in dark purple-brown, and longer (c. 15 mm), entire, membranous ligules.

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References

- Ardiyani, M., Anggara, A. & Leong-Škorníčková, J. (2011). Rediscovery of *Curcuma sumatrana* (Zingiberaceae) endemic to West Sumatra. *Blumea* 56: 6–9.
 Beentje, H. (2010). *The Kew Plant Glossary: an illustrated dictionary of plant terms*. Royal Botanic Gardens, Kew, Richmond, Surrey, UK.

- Burtt, B.L. & Smith, R.M. (1979). Notes on the collection of Zingiberaceae. *Fl. Males. Bull.* 29: 2599–2601.
- Craib, W.C. (1912). List of Siamese plants, with descriptions of new species — continued. *Bull. Misc. Inform. Kew* 10: 397–405.
- Holtum, R.E. (1950). The Zingiberaceae of the Malay Peninsula. *Gard. Bull. Singapore* 13: 1–249.
- Horaninow, P.F. (1862). *Prodromus Monographiae Scitaminearum. Typis Academiae Caesareae Scientiarum. Petropoli.*
- IUCN (2012). *IUCN Red List Categories and Criteria: Version 3.1. Second edition.* Switzerland, Gland and UK, Cambridge: IUCN.
- Kishor, R. & Leong-Škorničková, J. (2013). *Zingiber kangleipakense* (Zingiberaceae): A new species from Manipur, India. *Gard. Bull. Singapore* 65 (1): 39–46.
- Kress, W.J., Prince, L.M. & Williams, K.J. (2002). The phylogeny and a new classification of the gingers (Zingiberaceae): Evidence from molecular data. *Amer. J. Bot.* 89 (11): 1682–1696.
- Kress, W.J., DeFilipps, R.A., Fair, E. & Kyi, D.Y.Y. (2003). A checklist of the trees, shrubs, herbs, and climbers of Myanmar. *Syst. Bot.* 29 (2): 462–463.
- Larsen, K. (1980). Annotated key to the genera of Zingiberaceae of Thailand. *Nat. Hist. Bull. Siam Soc.* 28: 151–169.
- Larsen, K., Lock, J.M., Maas, H. & Maas, P.J.M. (1998). Zingiberaceae. In: Kubitzki, K. (ed). *The Families and Genera of Vascular Plants* 4: 474–495.
- Leong-Škorničková, J., Šída, O. & Marhold, K. (2010). Back to types! Towards stability of names in Indian *Curcuma* L. (Zingiberaceae). *Taxon* 59: 269–282.
- Leong-Škorničková, J., Šída, O., Bouamanivong, S., Souvannakhounmane, K. & Phathavong, K. (2014a). Three new ginger species (Zingiberaceae) from Laos. *Blumea* 59: 106–112.
- Leong-Škorničková, J., Thame, A. & Chew, P.T. (2014b). Notes on Singapore native Zingiberales I: A new species of *Zingiber* and notes on the identities of two further *Zingiber* taxa. *Gard. Bull. Singapore* 66(2): 153–167.
- Loesener, T. (1930). Zingiberaceae. In: Engler, A. & Prantl, K. (eds) *Die natürliche Pflanzenfamilien* 15a: 541–640.
- Ridley, H.N. (1899). The Scitamineae of the Malay Peninsula. *J. Straits Branch Roy. Asiat. Soc.* 32: 85–184.
- Ridley, H.N. (1909). The Scitamineae of the Philippines. *Philipp. J. Sci.* 4: 144–193.
- Sabu, M. (2003). Revision of the genus *Zingiber* in South India. *Folia Malaysiana* 4: 25–52.
- Sabu, M. (2006). Taxonomic revision of the genus *Zingiber* Boehm. in north-east India. *J. Econ. Taxon. Bot.* 30: 520–532.
- Škorničková, J. & Sabu, M. (2005). *Curcuma roscooeana* Wall. (Zingiberaceae) in India. *Gard. Bull. Singapore* 57: 187–198.
- Schumann, K. (1904). Zingiberaceae. In: Engler, H.G.A. (ed) *Das Pflanzenreich: regni vegetabilis conspectus*, IV, 46 (heft 20): 1–458.
- Smith, R.M. (1988a). A review of Bornean Zingiberaceae: V (*Zingiber*). *Notes Roy. Bot. Gard. Edinburgh* 45: 409–423.
- Smith, R.M. (1988b). Zingiberaceae. In: Noltie, H.J. (ed) *Flora of Bhutan* 3: 182–209.
- The Plant List (2013). The Plant List, version 1.1. <http://www.theplantlist.org/> (accessed on 1 Jan. 2013).
- Theerakulpisut, P., Triboun, P., Mahakham, W., Maensiri, D., Khampila, J. & Chantanothai, P. (2012). Phylogeny of the genus *Zingiber* (Zingiberaceae) based on nuclear ITS sequence data. *Kew Bull.* 67: 389–395.

- Theilade, I. (1996). Revision of the genus *Zingiber* in Peninsular Malaysia. *Gard. Bull. Singapore* 48: 207–236.
- Theilade, I. (1999). A synopsis of the genus *Zingiber* (Zingiberaceae) in Thailand. *Nordic J. Bot.* 19 (4): 389–410.
- Thongam, B., Sarangthem, N. & Konsam, B. (2013). *Zingiber kerrii* (Zingiberaceae): A new record for India from Manipur. *Taiwania* 58(4): 291–294.
- Triboun, P. (2006). *Biogeography and Biodiversity of the Genus Zingiber in Thailand*. PhD Thesis, Khon Kaen University, Khon Kaen (unpublished).
- Tong, S.Q. (1987). New plants of *Zingiber* from Yunnan. *Acta Phytotax. Sin.* 25 (2): 140–149.
- Valeton, T. (1918). New notes on the Zingiberaceae of Java and Malaya. *Bull. Jard. Bot. Buitenzorg* 27: 118–157.
- Wu, T.L. & Larsen, K. (2000). Zingiberaceae. In: Wu, Z.Y. & P.H. Raven (eds) *Flora of China* 24: 322–377.
- Zhang, Y.C. & Tang, K.Y. (1991). The studies of the northern boundary of subtropical zone and its transitional zone in China. *Geogr. Res.* 10 (2): 85–91.